5.4.1 NOR'EASTER

This section provides a profile and vulnerability assessment for the Nor'Easter hazard.

HAZARD PROFILE

This section provides profile information including description, location and extent, previous occurrences and losses, and the probability of future occurrences.

Description

Coastal storms that affect Long Island fall into two general categories: hurricanes (tropical cyclones) and extratropical storms (midatlantic cyclones, northeasters or Nor'Easters). Although both types of storms can cause a similar level of devastation to developed coastlines, they are vastly different with respect to origin and progression (Cashin Associates, 1994). Therefore, these two types of coastal storms are addressed as separate hazards within this HMP. Nor'Easters, named for the strong northeasterly winds that blow in ahead of these storms, are also categorized as a type of extratropical cyclone (mid-latitude storm, or Great Lake storm). A description of both Extatropical Cyclones and Nor'Easter is provided below.

Extra-Tropical Cyclone: Extratropical cyclones, sometimes called mid-latitude cyclones, are a group of cyclones defined as synoptic scale, low pressure, weather systems that occur in the middle latitudes of the Earth. These storms have neither tropical nor polar characteristics and are connected with fronts and horizontal gradients in temperature and dew point otherwise known as "baroclinic zones". Extratropical cyclones are everyday weather phenomena which, along with anticyclones, drive the weather over much of the Earth. These cyclones produce impacts ranging from cloudiness and mild showers to heavy gales and thunderstorms. Tropical cyclones often transform into extratropical cyclones at the end of their tropical existence, usually between 30° and 40° latitude, where there is sufficient force from upper-level shortwave troughs riding the westerlies (weather systems moving west to east) for the process of extratropical transition to begin. A shortwave trough is a disturbance in the mid or upper part of the atmosphere which induces upward motion ahead of it. During an extratropical transition, a cyclone begins to tilt back into the colder air mass with height, and the cyclone's primary energy source converts from the release of latent heat from condensation (from thunderstorms near the center) to baroclinic processes (Canadian Hurricane Centre, 2003).

Nor'Easter (abbreviated for Northeaster): A Nor'Easter is a macro-scale Extratropical storm whose winds come from the northeast, especially in the coastal areas of the Northeastern United States and Atlantic Canada. More specifically, it describes a low pressure area whose center of rotation is just off the coast and whose leading winds in the left forward quadrant rotate onto land from the northeast. Wind gusts associated with these storms can exceed hurricane forces in intensity. Unlike tropical cyclones that form in the tropics and have warm cores (including tropical depressions, tropical storms and hurricanes), Nor'Easters contain a cold core of low barometric pressure that forms in the mid-latitudes. Their strongest winds are close to the earth's surface and they often measure several hundred miles across. Nor'Easters may occur at any time of the year but are most common during the fall and winter months (September through April) (NYOEM, 2007).

Nor'Easters can cause heavy snow, rain, gale force winds, and oversized waves (storm surge) that can cause beach erosion, coastal flooding, structural damage, power outages and unsafe human conditions. If a Nor'Easter cyclone stays just offshore, the results are much more devastating than if the cyclone meanders up the coast on an inland track. Nor'Easters that stay inland are generally weaker and only

cause strong wind and rain. Those that stay offshore can bring heavy snow, blizzards, ice, strong winds, high waves, and severe beach erosion. In these storms, the warmer air is aloft. Precipitation falling from this warm air moves into the colder air at the surface, causing crippling sleet or freezing rain.

If a significant pressure drop occurs within a Nor'Easter, this change can turn a simple extratropical storm into what is known as a "bomb". "Bombs" are characterized by a pressure drop of at least 24 millibars within 24 hours (similar to a rapidly-intensifying hurricane). Even though "bombs" occasionally share some characteristics with hurricanes, the two storms have several differences. "Bombs" (being a type of Nor'Easter) are extratropical, and therefore, are associated with fronts, higher latitudes, and cold cores. They require strong upper-level winds, which would destroy a hurricane [Multi-Community Environmental Storm Observatory (MESO), 2002].

For the purpose of this HMP, only Nor'Easter events are being further discussed within this hazard profile, due to their significant historical impact on SC.

Location and Extent

Because SC is primarily surrounded by coastal waters, Nor'Easters affect the entire mitigation study area, particularly communities along the north and south shores of the County. Multiple sources document that SC has been impacted by many Nor'Easters. The county has felt the direct and indirect landward effects, including high winds, heavy rains, flash and coastal flooding, and beach erosion associated with several Nor'Easters.

Though the occurrence of a Nor'Easter can be forecasted with some accuracy, predicting their impact is more complex. The extent (that is, magnitude, severity, or intensity) of a Nor'Easter can be categorized by the Dolan-Davis Nor'Easter Intensity Scale. In 1993, researchers Robert Davis and Robert Dolan created this Nor'Easter intensity scale, but it deals primarily with beach and coastal deterioration. This scale, presented as Table 5-8, categorizes or rates the intensity of Nor'Easters from 1 (weak) to 5 (extreme) based on a storm class rating that is based on an estimate of the potential beach erosion, dune erosion, overwash, and property damage expected from a Nor'Easter (MESO, 2002).

Table 5-8. The Dolan-Davis Nor'Easter Intensity Scale

Storm Class	Beach Erosion	Dune Erosion	Overwash	Property Damage
1 (*Weak*)	Minor Changes	None	No	No
2 (*Moderate*)	Modest; mostly to lower beach	Minor	No	Modest
3 (*Significant*)	Erosion extends across the beach	Can be significant	No	Loss of many structures at local level
4 (*Severe*)	Severe beach erosion and recession	Severe dune erosion or destruction	On low beaches	Loss of structures at community level
5 (*Extreme*)	Extreme beach erosion	Dunes destroyed over extensive areas	Massive in sheets and channels	Extensive at regional-scale; millions of dollars

Source: (MESO, 2002)

Dr. Gregory Zielinski, Maine's state climatologist and an associate research professor at the University of Maine Institute for Quaternary and Climate Studies, has developed a Nor'Easter intensity scale that focuses on the impact of the winter weather events associated with Nor'Easters. He applies this scale not

only to Nor'Easters, but also for Great Lakes Storms, like the one that sank the Edmund Fitzgerald. In an article posted in the January 2002 issue of the Bulletin of the American Meteorological Society (BAMS), Dr. Zielinski explains: "My classification scheme allows forecasters and meteorologists to easily summarize the intensity of a winter storm by giving it an intensity index and placing it into its appropriate category on a 1-5 scale. The potential impact of the storm can then be passed on to public service officials so they may make plans for precipitation amounts, particularly snow, snowfall rates, wind speeds, drifting potential, and the overall impact on schools, businesses, travelers, and coastal communities." In Zielinski's classification system, a second number reflecting forward speed is used together with a number that is based on intensity. The second number ranges between 1 and 5. A 5 would be the slowest moving and thus longest duration storm. For example, a storm's category might be 2.4, reflecting an intensity of 2 with the first digit and duration of 4 with the second (MESO, 2002). Zielinski has used his scale in a historical investigation of New England's climate. He has classified more than 70 storms of the past, including the Great Arctic Outbreak of 1899, the Blizzard of 1888, and other storms that are part of U.S. weather lore. A December 2000 storm was the most intense found in his study (Zielinski, 2003).

Previous Occurrences and Losses

Nor'Easters frequently impact the County, because SC is surrounded by coastal waters to the north, east and south. Data provided by FEMA, NYSEMO and the NYS HMP on Presidential Declared Disasters identify six Presidential (DR) /Emergency (EM) Declarations associated with Nor'Easter events (with some of these event also listed as other types of hazards from different sources) (Table 5-9).

Table 5-9. Presidential Disaster Declarations for Nor'Easter Events in SC

Type of Event	Date	Declaration Number	Cost of Losses (approximate)
Nor'Easter / Coastal Flooding "Great Atlantic Storm of 1962") (Also identified as a Flooding Event)	March 6-8, 1962	DR-129	Resulted in nearly $130 million in damages and 40 deaths; however, quantity and location of damages was not reported (MESO 2002).
Nor'Easter ("Great Nor'Easter of 1992")	December 21, 1992	DR-974	Resulted in approximately $31.2 million in property damages to southeastern NYS. The type of damage, monetary losses, and location were not reported for SC.
Nor'Easter / Blizzard ("The Storm of the Century") (Also identified as a Winter Storm Event)	March 1993	EM-3107	Resulted in approximately $8.5 million in damages to NYS. The type of damage, monetary losses and location were not reported for SC.
Nor'Easter / Blizzard (Also identified as a Winter Storm Event)	January 6-8, 1996	DR-1083	$21.4 million in federal and state funds were provided to 150 municipalities in seven counties of NYS as part of the ongoing recovery from the Blizzard of '96.
Nor'Easter	October 19-20, 1996	DR-1146	Resulted in approximately $16.1 million in damages to southeastern NYS (particularly in Suffolk and Westchester Counties).
Nor'Easter (Listed by FEMA as a severe storm and coastal flooding)	April 14-16, 2007	DR-1692	According to U.S. Senator Charles E. Schumer, this event resulted in $26 million in damages to SC. Disaster aid from FEMA has not been determined.

Source: (FEMA, 2007; NYSEMO, 2006)
DR – Presidential Declaration, EM – Emergency Declaration. Notes: Losses indicate the value of loss in terms of payments made to recipients; this data is made available through public records and does not reflect all losses incurred.

Based on all sources researched, 23 notable Nor'Easter/Extratropical Cyclone events have directly or indirectly impacted SC between 1931 and 2006, as summarized in Table 5-10 below.

Table 5-10. Nor'Easter Events between 1931 and 2006

Event Date / Name	Location	Losses / Impacts	Source(s)
Nor'Easter October 24, 1897	SC	Separated Orient Village from the North Fork	Governor's Coastal Erosion Task Force 1994
Nor'Easter March 4, 1931	SC	Created Moriches Inlet, severe beach erosion and structural damage	Scott Mandia -The Long Island Express (SUNY) http://www2.sunysuffolk.edu/mandias/38hurricane/geological_impact.htm, NPS http://www.ci.uri.edu/naccesu/FIIS_page/Psuty_etal_oceanshore_final.pdf
Nor'Easter November 25, 1950	SC	NA	FEMA Flood Insurance Study (May 4, 1998)
Nor'Easter November 6-7, 1953	SC	NA	FEMA Flood Insurance Study (May 4, 1998)
Nor'Easter October 14-16, 1955	SC	NA	FEMA Flood Insurance Study (May 4, 1998)
Nor'Easter April 13, 1961	SC	NA	FEMA Flood Insurance Study (May 4, 1998)
Nor'Easter / Flooding March 6-8 1962 (FEMA DR-129) "Ash Wednesday Storm" or "Great Atlantic Storm of 1962"	Southeastern NYS, throughout L.I.	Resulted in total damages of $130 M in damages and 40 deaths, $714 K in disaster aid throughout SC, Millions in damages to Fire Island	MESO, FEMA Flood Insurance Study (May 4, 1998), FEMA, SHELDUS, NYS HMP, NPS (http://www.ci.uri.edu/naccesu/FIIS_page/Psuty_etal_oceanshore_final.pdf)
Nor'Easter November 12-13, 1968	SC	NA	FEMA Flood Insurance Study (May 4, 1998)
Nor'Easter / Blizzard February 1969	L.I.	25 + inches of snow	Patchogue Village Document - http://www.patchoguevillage.org/hazmit/02%20-%20Steps/Step%2004/Text%20and%20Figures.pdf
Nor'Easter February 19, 1972	SC	NA	FEMA Flood Insurance Study (May 4, 1998)
Nor'Easter November 7, 1973	SC	NA	FEMA Flood Insurance Study (May 4, 1998)
Nor'Easter February 6-7, 1978 (one of largest)	SC (North Shore - Peconic Bay)	NA	FEMA Flood Insurance Study (May 4, 1998)
Nor'Easter October 30-31, 1991 "The Perfect Storm" or "Halloween Storm of 1991"	Northeastern U.S.	$2.6 B in total damages, 9 deaths (1 of top 3 erosion events)	MESO, www.Hurricanes-Blizzards-noreasters.com
Nor'Easter December 11-13, 1992 (FEMA DR-974)	Southeastern NYS	Approx. $31.2 M in damages, severe beach erosion on South Shores, destruction in North Fork, new inlets, 100 + structures	FEMA, NYS HMP, NYSEMO, MESO, Newsday.com (Mintz), www.Hurricanes-Blizzards-noreasters.com, Patchogue Village Document - http://www.patchoguevillage.org/hazmit/02

Event Date / Name	Location	Losses / Impacts	Source(s)
		damaged	%20-%20Steps/Step%2004/Text%20and%20Figures.pdf, Governor's Coastal Erosion Task Force 1994
Nor'Easter / Blizzard March 12-14, 1993 (FEMA EM-3107) "Superstorm of 1993" or "Storm of the Century" Also identified as a Winter Storm	Statewide	Approx. $8.5 M in total damages	FEMA, NYS HMP, NYSEMO, MESO, Patchogue Village Document - http://www.patchoguevillage.org/hazmit/02%20-%20Steps/Step%2004/Text%20and%20Figures.pdf
Nor'Easter January 1994	SC	NA	www.Hurricanes-Blizzards-noreasters.com
Nor'Easter / Blizzard January 6-8 1996 (FEMA DR-1083) "Blizzard of '96"	Southern NYS	Approx. $21.4 M, 27+ inches of snow throughout NYS	FEMA, NSIDC, Northshore Wx, http://www.hurricanes-blizzards-noreasters.com/, NYS HMP
Nor'Easter October 19-20, 1996 (FEMA DR-1146)	Northeastern U.S., Suffolk and Westchester Counties	Approx. $16.1 M in total damages (NYS HMP) - Approx. $3.5 M in disaster aid to the two counties, $286 K in additional federal aid to SC	FEMA, NYS HMP, NYSEMO, MESO, Governor Pataki Press Release
Nor'Easter March /April 1997 "April Fools Nor'Easter"	L.I.	12 + inches of snow	Patchogue Village Document - http://www.patchoguevillage.org/hazmit/02%20-%20Steps/Step%2004/Text%20and%20Figures.pdf
Nor'Easter March 5-7, 2001	Central L.I. - SC (Most snow: Centereach, Huntington, Ridge)	Unknown	North Shore Wx
December 26, 2002 "Christmas Nor'Easter"	SC (Dix Hills, Centereach, Lindenhurst, and Islip)	Snow amounts ranged from 9 to 20 inches	NWS – NYC/Upton Public Information System
Nor'Easter February 2003	L.I.	Total losses = $20 M throughout northeastern U.S. (14 - 24 inches of snow)	Patchogue Village Document - http://www.patchoguevillage.org/hazmit/02%20-%20Steps/Step%2004/Text%20and%20Figures.pdf
Nor'Easter December 2003	L.I.	Moderate to severe erosion on some South Shore beaches	Newsday.com (Mintz)
Nor'Easter February 11, 2006	Multi-State	Islip received 20 inches of snow)	Wikipedia - http://en.wikipedia.org/wiki/North_American_blizzard_of_2006#New_York

Event Date / Name	Location	Losses / Impacts	Source(s)
Nor'Easter April 14-16, 2007 (FEMA DR-1692)	Multi-State	Major flooding and coastal erosion throughout County (Approximately $26 M in damage)	Newsday.com, Wikipedia, NY Times, Senator Charles Schumer Press Release (April 30, 2007), FEMA

Notes:

B	Billion
DR	Federal Disaster Declaration
EM	Federal Emergency Declaration
FEMA	Federal Emergency Management Agency
HMP	Hazard Mitigation Plan
K	Thousand ($)
L.I.	Long Island
M	Million ($)
MESO	Multi-Community Environmental Storm Observatory
NA	Not Available
NOAA-NCDC	National Oceanic Atmospheric Administration – National Climate Data Center
NRCC	Northeast Regional Climate Center
NSIDC	National Snow and Ice Data Center
NWS	National Weather Service
NYS	New York State
NYSEMO	New York State Emergency Management Office
NYS HMP	New York State Hazard Mitigation Plan (2004)
SC	Suffolk County
SHELDUS	Spatial Hazard Events and Losses Database for the United States
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture

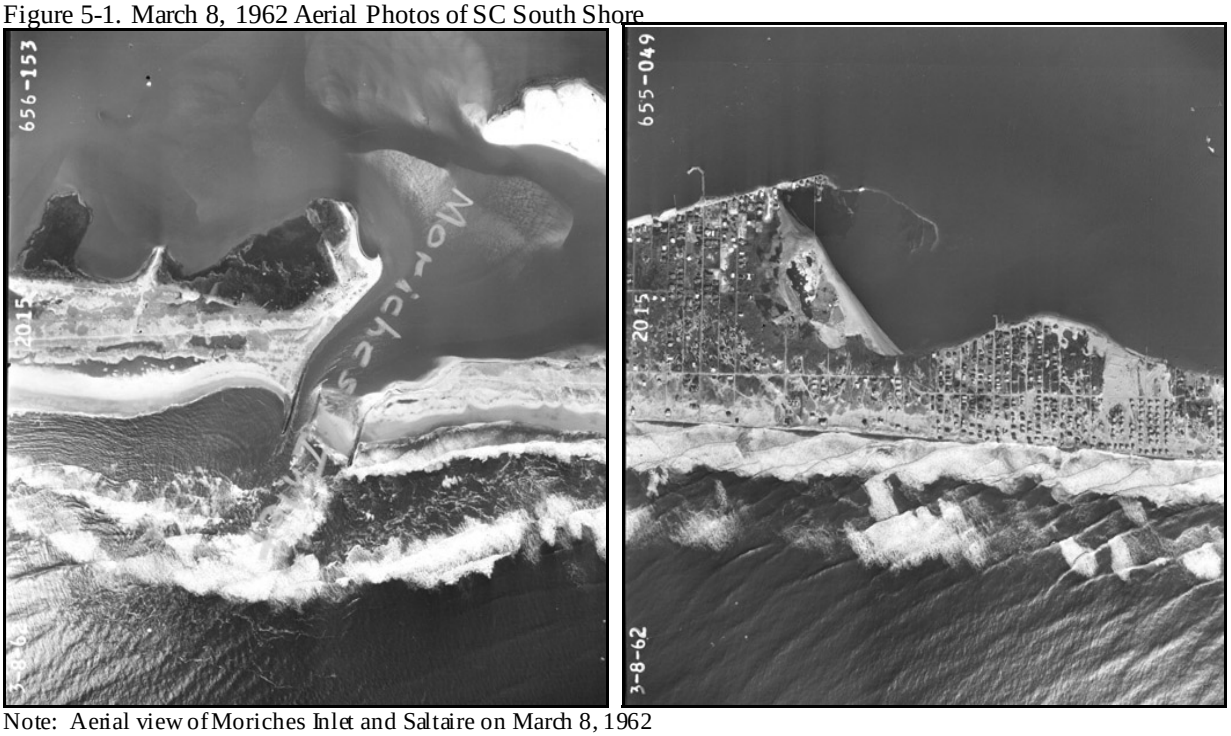
Details regarding significant Nor'Easter events that have impacted SC include, but are not limited to, the following:

March 6-8, 1962 (FEMA DR-129) ("Ash Wednesday Storm"): According to FEMA, SHELDUS, and the 2004 NYS HMP, this event, which has also been identified as a coastal flooding event by some sources, impacted southeastern NYS. Long Island communities, such as Fire Island were decimated with over 100 homes destroyed from this event (Watson, 2006). The USACE indicated that this flooding event caused a total of 50 washovers and formed one new inlet at Westhampton Beach. On Fire Island, a total of 47 homes were destroyed and 75 were damaged resulting in property losses estimated in the millions. Twelve square miles of the mainland were inundated; under current development conditions, a recurrence of these flood stages would mean that approximately 4,500 structures would be inundated up to 6 feet in depth. As a result of this storm, the New York District of the USACE constructed emergency protective works throughout the study area ("Operation Five-High"). Assistance was provided to the local communities to in the removal of debris, and in the rebuilding of beaches and dunes. One of the first response actions of the Corps was to assist in the closure of the breach at Westhampton. In total, over 2 million cubic yards of material were used to rebuild over 23 miles of beaches and dunes in the study area (USACE, Date Unknown). According to SHELDUS, this event resulted in approximately $714,000 in property damages to the County.

Another source indicates that the storm resulted in over 75 breaks (washovers) between Fire Island Inlet and Southampton. The largest breach was about 400 meters wide and occurred at Westhampton Beach. In the Moriches to Shinnecock Reach, large stretches of Dune Road and 46 houses were destroyed. A notable occurred at Shinnecock Inlet: the west side eroded and accretion occurred along the east side. President Eisenhower declared the south shore a disaster area eligible for Federal aid. Under authority of

Public Law 875, the USACE performed engineering and construction of emergency shore protection and rehabilitation. Some 2,210,000 cubic yards of sand was pumped onto beaches, mostly from back bays ().

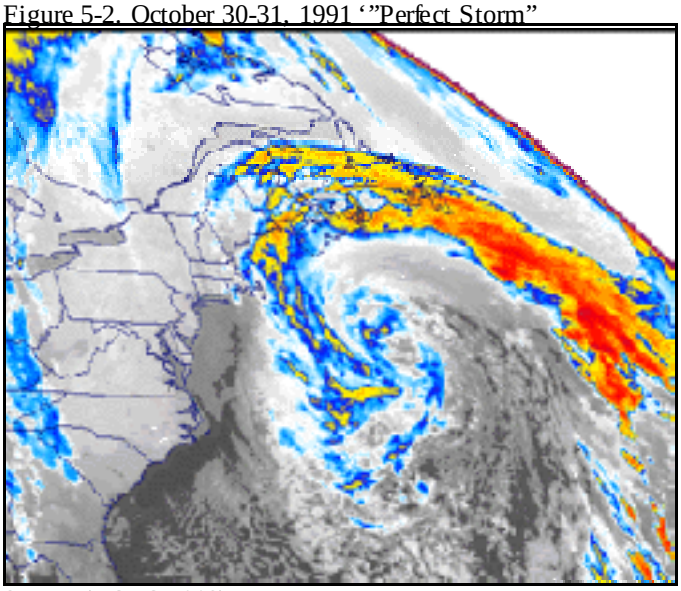
Figure 5-1. March 8, 1962 Aerial Photos of SC South Shore



Note: Aerial view of Moriches Inlet and Saltaire on March 8, 1962
Source: (Historical Aerial Photos, Date Unknown)

October 30-31, 1991 ("The Perfect Storm" or "Halloween Storm of 1991"): This storm was an unusual Nor'Easter which was extratropical. This storm also absorbed one hurricane, before it ultimately evolved into a small hurricane late in its life cycle. The unnamed hurricane of 1991 was the last tropical cyclone of the 1991 Atlantic hurricane season, and its fourth hurricane. By November 2, Atlantic Canada experienced the effects of this land-falling tropical storm. Damage totals neared $1 billion (1991 USD) and deaths climbed to 12 people. Most of the damage occurred while the storm was extratropical. The hurricane was the second costliest storm of the season, behind only Hurricane Bob, which caused $1.5 billion in damages (1991 USD, $2.1 billion 2005 USD) (Wikipedia, 2007). Damages totaled over $10 million throughout NYS and northern New Jersey as a result of this storm and the two states received the most damage to coastal sections since the Great Atlantic Hurricane of 1944. Homes, boats, roads, beaches and seawalls were destroyed; numerous boats were damaged or destroyed at their berths; and three boats sunk on Long Island Sound (all on board rescued). As provided by NOAA-NCDC, Figure 5-2 depicts the monster storm off the Eastern Seaboard (NCDC, 2004).

Figure 5-2. October 30-31, 1991 '"Perfect Storm"



Source: (NCDC, 2006)

Note: The color-enhanced infrared image of 1200 UTC October 30, 1991 depicts a monster storm off the Eastern Seaboard, which was described by the National Weather Service as the "perfect storm." In this image, the storm was at its peak intensity. The storm became subtropical thirty hours later, just before the inner core of the storm developed into a topical storm and later an unnamed hurricane.

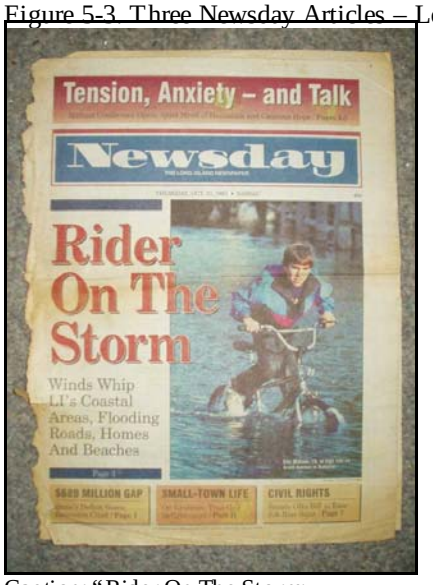
The worst hit areas in SC included Westhampton, Ocean Beach, Southampton, Montauk, Smith Point, Southold, Fire Island, Babylon, East Hampton, Shelter Island and Orient Beach. This storm caused heavy flooding and severe erosion across Long Island. A tidal surge with waves as high as 15 feet occurred in some places, engulfed the shores, sheered off sweeping stretches of beach from Montauk to Freeport, and punched holes in environmentally sensitive barrier beaches. This event appeared to be one of the top three erosion events in the area's history (Figure 5-3). It caused more beach erosion then other recent hurricanes at the time (such as Hurricanes Bob and Gloria). Restoration of the SC beaches was expected to cost considerable money. Senator Alfonse D'Amato estimated the damage at tens of millions of dollars (including damage to houses and barrier beaches) (Long Island Hurricane History, 2007). Damage to Townships, Villages and Hamlets in SC included, but were not limited to, the following:

- Babylon: Gilgo Beach in Babylon scoured away. On the south shore of Babylon the water was so high at Gilgo Beach that it almost the covered tops of picnic tables. A layer of sand five-feet deep disappeared from Babylon Beaches.
- Shelter Island: Tides 5 to 8 feet above normal flooded Ram Island causeways on Shelter Island causing an eroded Crescent Beach.
- Southold: Significant flooding in St. Jamesport at Peconic Bay. Orient Beach experienced significant damage, causing it to close for an extended period of time. The roadway to the beach was undermined and caved in and the park was completely flooded. The access road to Orient Beach State Park was severed in 10 places. This was on of the hardest hit beaches in Long Island.
- East Hampton: 150 feet of beach was lost at Napeague State Park. On the north side of Montauk, at mouth of Lake Montauk, water washed over Gosman's Dock. A 20-foot section of West Lake Drive collapsed from flood waters. In addition, 10 feet of bluff on each side of Montauk Lighthouse was carved out. At the Ocean Beach ferry terminal, the point where the dock ended

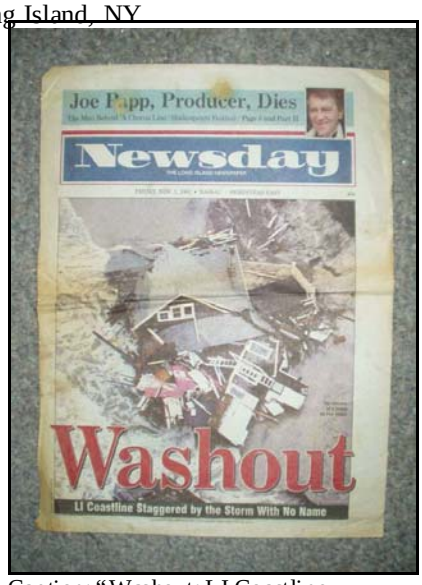
and land began could not be identified due to the flood waters. A dozen propane tanks and an electric dryer floated among the debris.

- Islip: Ocean Beach was found underwater. Islip was issued an evacuation order for Fire Island.
- Southampton: Southampton was found underwater. In Westhampton, an Air National Guard helicopter from Westhampton, with 5 crew aboard, went missing after it went down in rough waters. The storm washed away several houses on Dune Road in Westhampton Beach. One of the hardest hit areas was Dune Road (Figure 5-4); the barrier beach was breached in two places, dozens of homes were destroyed, and thousands of feet of roadway were ruined. One house was turned 180 degrees on its foundation by a powerful wave. More than two dozen ocean front homes in Westhampton were destroyed and left as debris after 10 to 15 foot waves crashed over Dune Road along more then a mile long section. Many houses were buried in sand and debris. Between 1,500 and 2,000 feet of Dune Road were clearly washed away.
- Fire Island: Four people in boats that were capsized by waves fell into the icy water and were admitted to hospitals to address hypothermia. Several 40-foot dunes on Fire Island were leveled. Multiple homes were destroyed (Figure 5-5). Raw sewage was reported leaching from cesspools and septic tanks in some areas of the Island and residents who use well water were urged to boil water (Long Island Hurricane History, 2007).

Figure 5-3. Three Newsday Articles – Long Island, NY



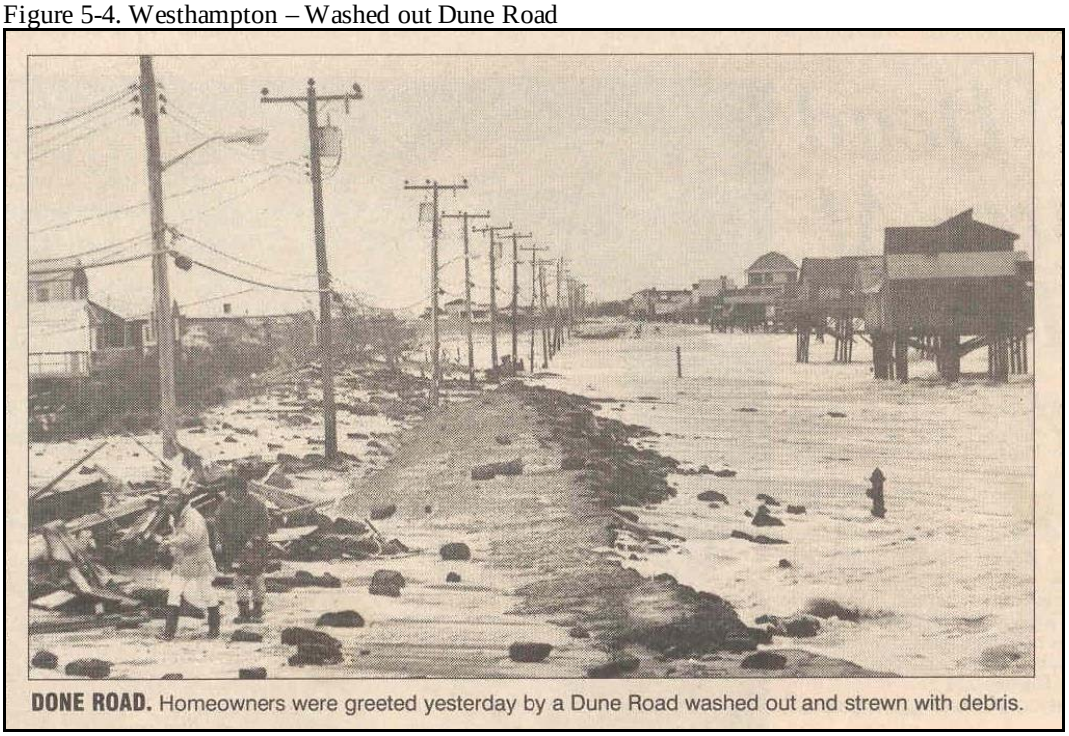
Caption: "Rider On The Storm: Winds Whip LI.'s Coastal Areas, Flooding Roads, Homes and Beaches" (Photo taken in Babylon). Source: (Long Island Hurricane History, 2007)



Caption: "Washout: LI Coastline Staggered by the Storm with No Name" (Photo taken in Fire Island)

Caption: "Blow by Blow: State Declares Long Island a Disaster Area, Barrier Beaches Remain in Jeopardy, Dune Road Home Owners Deal with the Lose." (Photo taken in Westhampton).

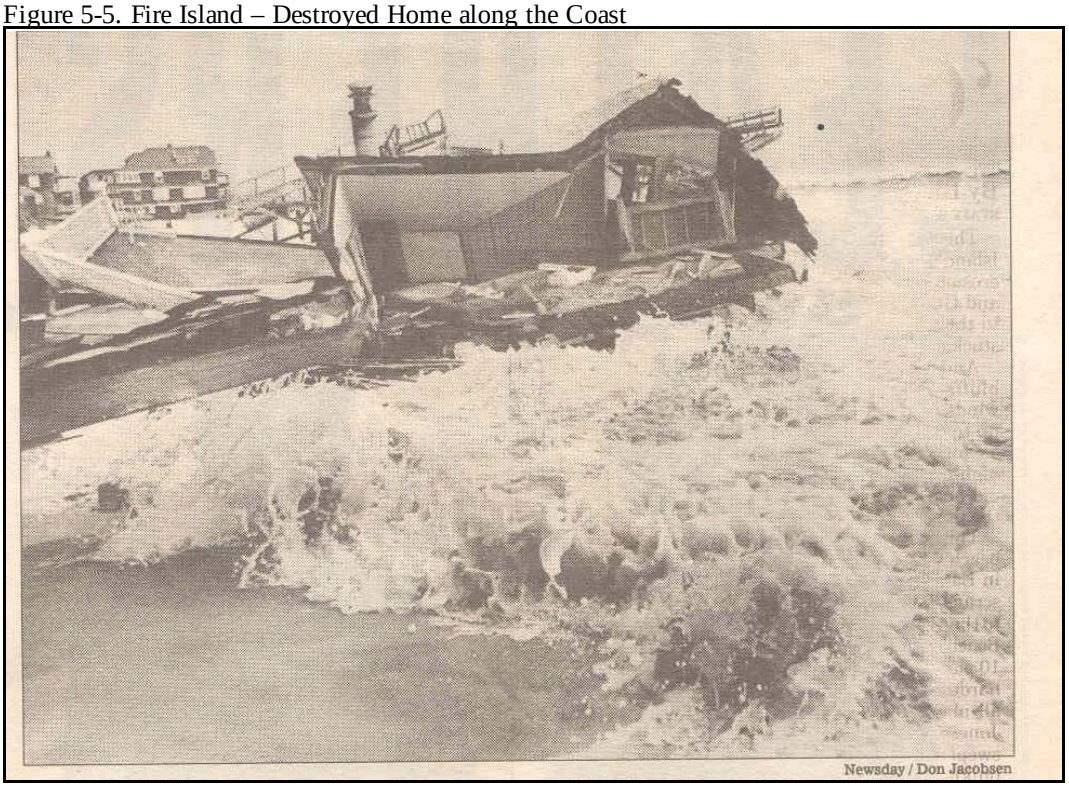
Figure 5-4. Westhampton – Washed out Dune Road



DONE ROAD. Homeowners were greeted yesterday by a Dune Road washed out and strewn with debris.

Source: (Long Island Hurricane History, 2007)

Figure 5-5. Fire Island – Destroyed Home along the Coast



Caption: "Ocean Demolition-Whipped by winds as high as 62 miles and hour, waves smash a house to pieces on Fire Island during the storm Wednesday afternoon." Source: (Long Island Hurricane History, 2007)

December 11-13, 1992 ("The Nor'Easter of 1992") (FEMA DR-974): Governor Mario Cuomo's Coastal Erosion Task Force Final Report, dated September 1994, states that this storm resulted in significant damage to SC. This winter storm, along with a series of other less damaging storms between 1992 and 1993 (e.g. March 12-14, 1993 Nor'Easter), caused widespread physical problems, including extensive beach erosion, dune scarping and overwash, bluff erosion, flooding, significant structural damage, and the disruption of transportation, utilities, and essential services.

This storm caused torrential rains, gusting winds, massive flooding, power outages, and property damage. Basements were flooded, trees and utility poles were downed, and traffic was snarled. This storm caused about $1 to $2 million in damages and other costs and caused 19 deaths throughout the northeastern U.S., which included Long Island, NY (Patchogue Village, 2006). It was identified as one of the worst Nor'Easters in four decades and one of worst coastal storms to hit Long Island. More than 100 homes on Long Island were destroyed and thousands more were damaged. Over $10 million in damages were reported to SC South Shore beaches, town properties, and homes.

The worst hit areas in SC included Babylon, Riverhead, Port Jefferson, Lindenhurst, Sag Harbor, Shelter Island, Asharoken-Eatons Neck, Orient, Fire Island, Lloyd's Neck, Montauk, Lake Ronkonkoma, Westhampton, Mastic Beach, Amityville, Saltaire, Copiague, Wading River, Brookhaven, Setauket, Smithtown, and Southampton. This two-day Nor'Easter tore vast amounts of sand from the South Shore beaches, ravaged the North Shore, and carved a new inlet through Dune Road in Westhampton (Mintz, 2004). Many state parks were closed including Captree, Jones Beach, Robert Moses, Orient Beach, and the Planting Fields Arboretum. About 448,000 Long Island homes lost power at one time or another during the storm (40% of LILCO customers) (Figure 5-6). From Lloyd Harbor to Wading River, cars were submerged on flooded roadways and high voltage wires snapped. As tides averaged 5 to 15 feet above normal, some areas remained inaccessible, 60,000 homes were still without power on the second day of the storm and many had no heat. Specific damage to Townships, Villages, and Hamlets in SC include, but are not limited to, the following:

- Babylon: Natural gas service shut off to about 2,400 homes in most in danger of flooding, such as Babylon, Lindenhurst, Amityville and Copiague. Flooding forced evacuations in Babylon where water swept over Montauk Highway. A half mile of beach on Cedar and Gilgo Beaches was submerged, water had breached bulkheads and flooded homes, and picnic tables were underwater. At Gilgo Beach, thousands of tons of sand that had been backfilled during the past several weeks as part of an Army Corp dredging project, was gone. LILCO gas service was shut off to flood prone areas south of Montauk highway in Babylon and Lindenhurst, which would affect 4,000 homes. Street flooding in Amityville is identified in Figure 5-7.

- Brookhaven: Worst damage along SC's north shore appeared to be in Port Jefferson. Officials estimated that at least one mile of beach was lost and the boardwalk was swept out to sea with $400,000 in damage. Merchants in Port Jefferson averaged that tens of thousands of dollars in damage would cripple holiday businesses along Main Street. The village was inundated with more then 6 feet of water, causing many cars to be submerged. Mastic Beach was underwater. In Brookhaven, large trees fell across Brookhaven roadways, including an aged maple measuring more then 30 inches in diameter which blocked traffic along Main Street in Setauket. Cedar Beach near Sound Beach absorbed its worst pounding from storm damage since at least WWII.

- East Hampton: People were found stranded on Lazy Point near Amagansett. In Sag Harbor, there was waterfront erosion along Bluff Point and the Redwood section.
- Fire Island: The storm breached Fire Island in five places in Atlantique, Ocean Bay, Dunewood, and Cornell Estates. Eleven homes were destroyed and many were damaged. A dune was breached and the water was 150 feet away from the road. Fire Island lost about 16 homes.

Western stretches of Fire Island beach and adjacent parts of Robert Moses were covered with lumber, shingles, household appliances, and possible dangerous propane tanks. A hull of a wooden ship, possibly dating to the turn of the century, poke through the sand. Because of the many dangers on the Fire Island, it was closed to the public.

- Huntington: Eaton Neck and Asharoken were cut off from the mainland by 5 feet of water. Wires were down and homes were flooded. On Eaton's Neck, there was no heat, electricity and access to mainland as a result of storm. Over 1,500 residents were cut off from the mainland and four homes were washed into the water. In Lloyd Neck, water inundated the main road and ripped up docks and beach steps. In Northport Harbor, the rising water covered the village dock and crept into the harborside park. In Centerport, Mill Dam Bridge was closed and flooding of Halesite and Huntington Bay. First time in 30 years that the causeways to Lloyd's Neck and Asharoken were both under water. Parts of Asharoken remained under water deep enough to prevent the NYS Army National Guard from getting to Eaton's Neck residents.

- Islip: Homes and surrounding properties in Saltaire were worth at least $350 K, which many were lost or damaged. Beach erosion and movement of water caused the shoreline to almost be instantly redrawn. One house was lost in Saltaire, all of the dunes and 18 feet of boardwalk were swept away.

- Riverhead: In Riverhead, a kayaker paddled down Peconic Bay Blvd. The sea surged into Peconic Bay, pushing a wall of water into the Peconic River, flooding parts of downtown Riverhead.

- Shelter Island: There was extreme flooding and a lot of damage. One house was lost to a fire and many houses had their roofs blown off.

- Smithtown: Finger slips and docks stored at the town's harbor facility were ripped from their concrete moorings. Callahans Beach in Kings Park suffered some erosion. Nissequogue River was flooded near the Landing Avenue Bridge, and for the first time, Jericho Turnpike flooded near the Smithtown Bull statue.

- Southampton: Worst damage along SC's south shore appeared to be in Westhampton, with 25 homes swept into the sea. According to a Governor Pataki news release, the Shinnecock Inlet has experienced increasing erosion (a problem that culminated as a result of a washout and breach that followed the December 1992 Nor'Easter). This event forced the commercial fishing fleet to temporarily abandon its home port, which generates an annual catch valued at more the $15 million (Long Island Hurricane History, 2007).

Additional town specific damage information is identified in a June 1994 Final Report-Environmental Study of the Barrier and Bay Island Communities in the Town of Babylon, produced by Cashin Associates, P.C. (Cashin, 1995). This report documents that the storm caused severe coastal flooding and erosion damage throughout various sections of the Town of Babylon. The Town of Babylon's Outer Beach communities experienced relatively minor flood damage; however, damage in other communities along coastal Long Island were much more severe, including Bayville and Asharoken on the north shore and Fire Island and Westhampton Beach on the south shore. The magnitude of storm damage within this area included the following:

- Fire Island Inlet: A dredging/beach nourishment project which entailed widening Gilgo Beach with dredge spoil (0.8 million cubic yards) was underway when the Nor'Easter hit. This storm washed away most of the sand that was placed along the Gilgo Beach during this project. Dune erosion also was severe at the West Gilgo Beach ocean shoreline. The loss of dune material at

this location resulted from toe erosion (when storm waves wash materials from the base of the dunes, causing the overlying dune sediments to slide down to the beach).

- Complete dune washout occurred along most of the 3,000-foot long segment of shoreline extending westward from the Gilgo Beach community.

- Flooding occurred at a number of locations within the residential communities of the Outer Beach (particularly at Gilgo Beach and Oak and Captree Islands). Flood waters penetrated the first floor of a number of houses at these locations.

- The boardwalk that extended along the entire length of Oak Island was severely damaged with large sections of walkway obliterated (Cashin 1994).

A September 1994 Governor's Coastal Erosion Task Force (Final Report Volume One - Emergency Response to Coastal Storms), indicates that this Nor'Easter event resulted in a significant amount of coastal erosion along a majority of SC's shorelines. The December Nor'Easter of 1992 and other less damaging 1993 winter storms (e.g., March 12 to 14, 1993 Nor'Easter), caused widespread physical problems, including extensive beach erosion, dune scarping, and overwash, bluff erosion, flooding, significant structural damage, and disruption of transportation, utilities and essential services. FEMA reported that direct federal disaster assistance through July 1993, which includes disaster funds for the December 1992 storm and the March 1993 storm, totaled $233.6 million. This storm proved highly destructive to transportation, utilities and essential services. Dune Road was severed by the breaches at Westhampton and broken by the washover west of Shinnecock Inlet. Ocean Parkway was in jeopardy of breaching. Babylon, Mastic Beach, and Shirley all reported problems with street flooding. In the Town of Smithtown, the sole access roads to the Short Beach and Long Beach peninsulas were flooded. Residents of Eaton's Neck were isolated by flooding at Asharoken Avenue. After the storm, beaches, dune washovers, and developed areas that experienced flooding or wave damage were littered with pieces of building materials from broken decks, boardwalks, docks, and shorefront homes. Jones Beach and Robert Moses State Park reportedly had between 4,000 and 5,000 cubic yards of stockpiled debris after cleanup efforts. Other impacts from the storms include;

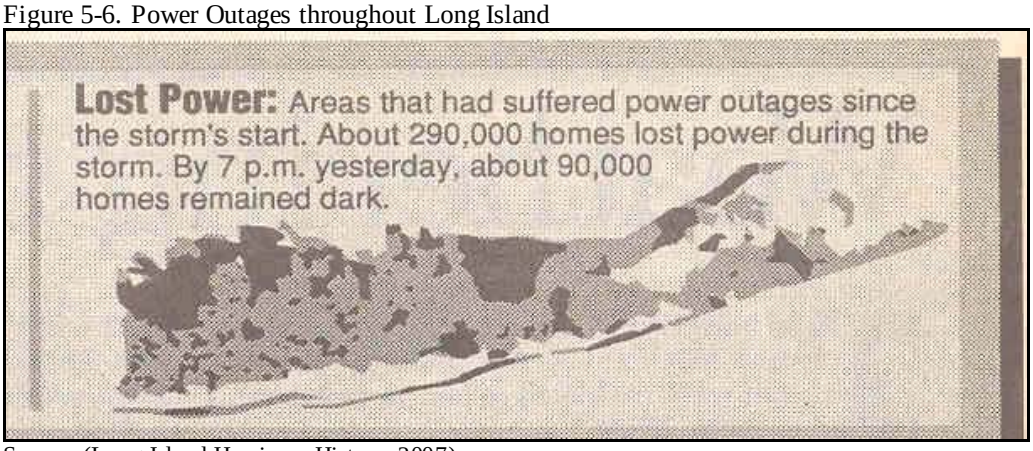
- Serious flooding of streets and houses occurred in Mastic and Shirley Beaches in Town of Brookhaven.

- Serious flooding resulted along the lower Browns River Road and access to the Bay Shore Marina in the Town of Islip.

- Extensive flooding in the Village of Remsenburg in the Town of Southampton (Cuomo, 1994).

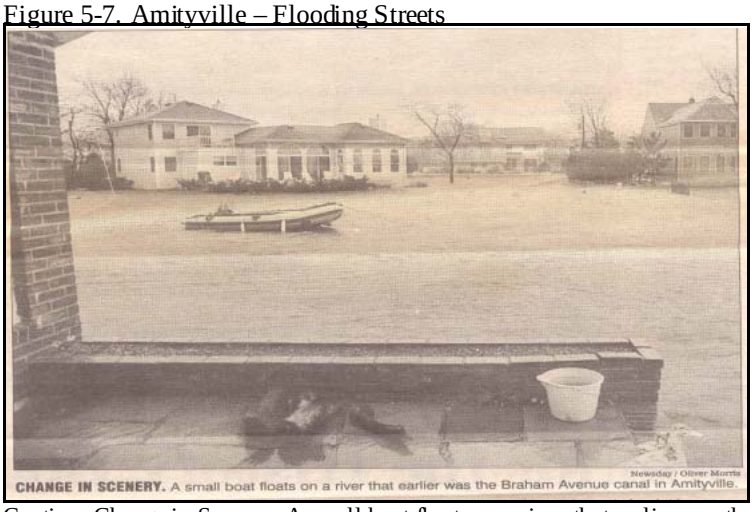
Details regarding coastal erosion impacts from this storm are presented later in this section (Section 5.4 - Coastal Erosion).

Figure 5-6. Power Outages throughout Long Island



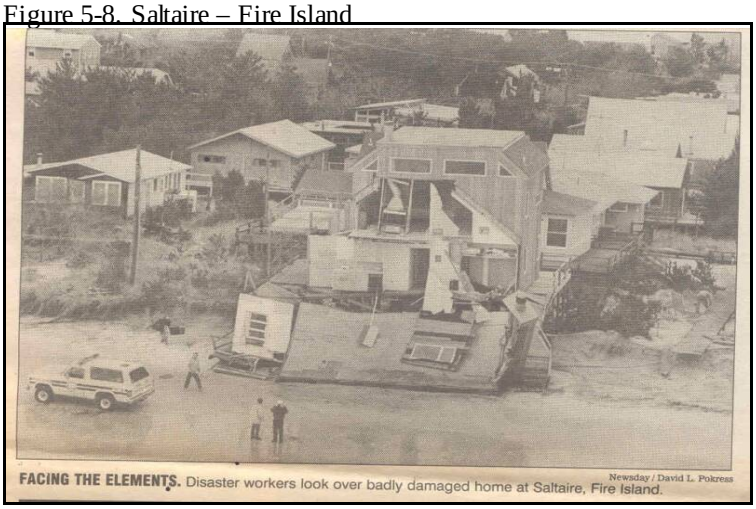
Source: (Long Island Hurricane History, 2007)
Note: Power outages were severe in Riverhead, Southold, Brookhaven and Fire Island.

Figure 5-7. Amityville – Flooding Streets



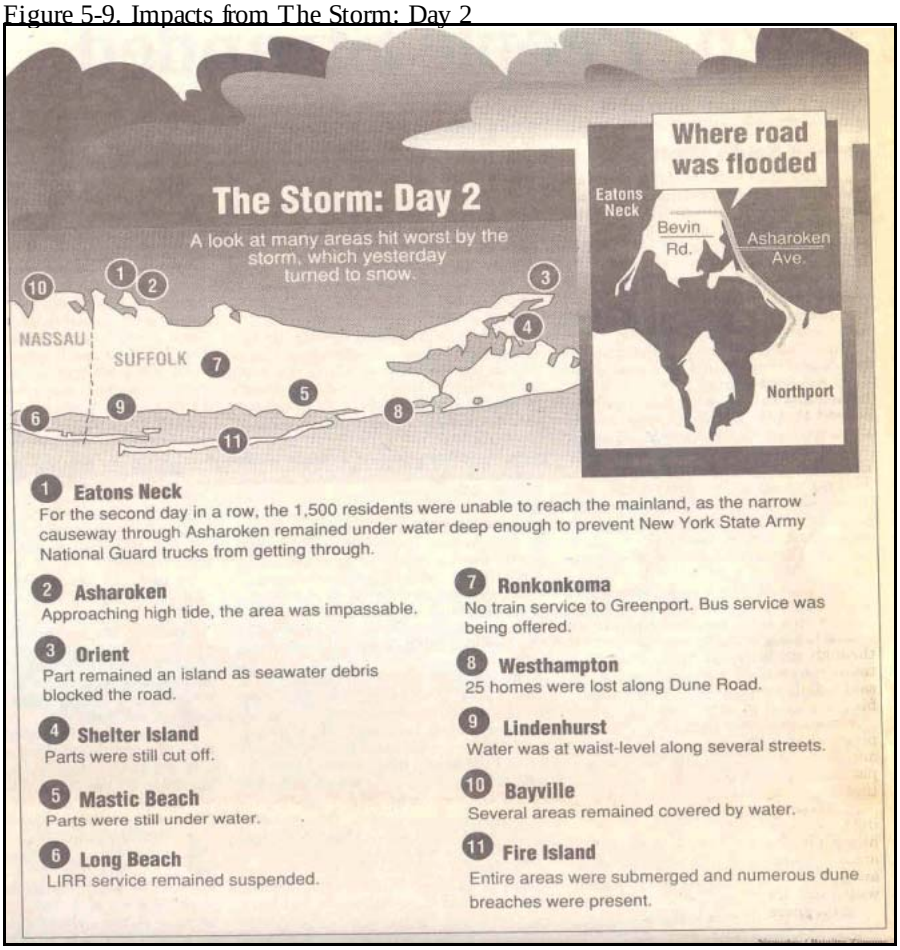
Caption: Change in Scenery: A small boat floats on a river that earlier was the Braham Avenue canal in Amityville.
Source: (Long Island Hurricane History, 2007)

Figure 5-8. Saltaire – Fire Island



Caption: Facing the Elements: Disaster workers look over badly damaged home at Saltaire, Fire Island.
Source: (Long Island Hurricane History, 2007)

Figure 5-9. Impacts from The Storm: Day 2



Source: (Long Island Hurricane History, 2007)

Figure 5-10. Great South Bay (Oak Island)

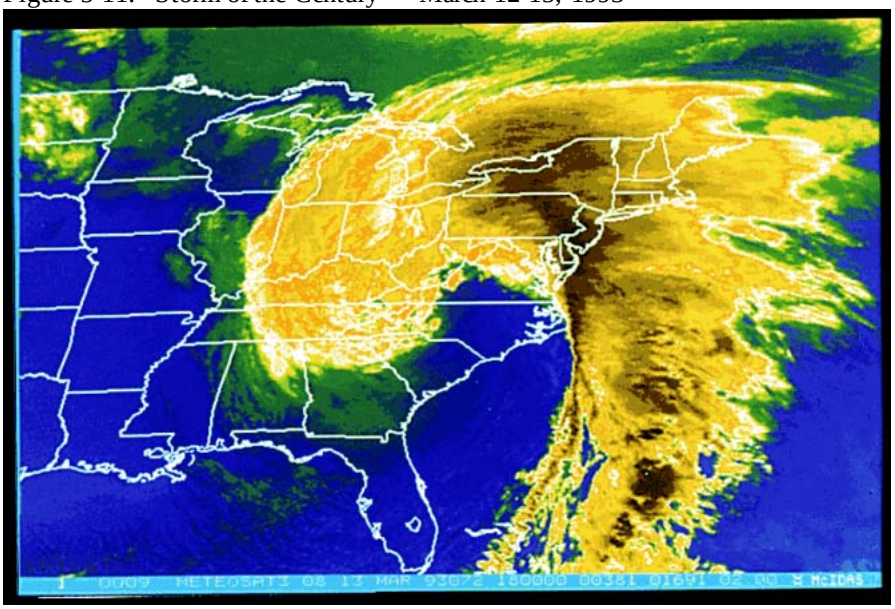
Source: (SSERC, 2000)

March 12-15, 1993 ("Superstorm of 1993," "Storm of the Century" or "Great Storm of 1993") (FEMA DR-3107): This storm was identified as a Nor'Easter and a blizzard by many sources; therefore, this event is also mentioned later in this section (Section 5.4 - Severe Winter Storms). It resulted in a FEMA Emergency Declaration (EM), including SC, identified as EM 3107. It was a massive storm complex, affecting at least 26 U.S. states and much of eastern Canada (Figure 5-11).

According to the NCDC Technical report 93-01: "A Review Of The March 12-14, 1993 "Storm of the Century," this storm reportedly caused over $6 billion in damages along the eastern coast of the U.S and resulted in over 270 fatalities (23 fatalities in NYS) (Lott, 1993). According to NYSEMO, the 1993 blizzard resulted in total eligible damages of approximately $8.5 million across NYS. Damage on Fire Island was extensive. The New York Times reported that 12,000 homes sustained storm damages, including on Fire Island. The storms were so powerful, they scoured from 70 to 100 feet of beach away, along almost the entire length of the island. Dunes were reduced to 0 to 8 feet in most places from their previous 15 to 25 feet (Ocean Beach and Fire Island, 2002).

According to a Patchogue Village HMP, hundreds of roof collapses occurred in the northeast due to the weight of heavy wet snow during this storm. Over 3 million customers were without electrical power in the region due to fallen trees and high winds, which damaged power utility infrastructure. At least 18 homes fell into the sea on Long Island due to the pounding surf. This storm was the 4th costliest storm in U.S. history (Patchogue Village, 2006). Specific monetary losses for SC are not documented.

Figure 5-11. "Storm of the Century" – March 12-15, 1993



Note: METEOSAT Infrared Satellite Photo of the March 1993 "Storm of the Century" (March 13, 1993)
Source: (NOAA, Date Unknown)

October 19-20, 1996 (FEMA DR-1146): The October 19-20, 1996 Nor'Easter delivered a devastating blow that was felt in Long Island and New York City. According to Mayor Rudolph Giuliani, the storm, which dumped nearly 4.8 inches of rain on the city and surrounding areas, caused significant damage to more than 1,000 homes, some of which remain uninhabitable to this day. All five boroughs of New York City and the counties of Nassau and Suffolk were declared major federal disaster areas as a result of damage to homes and businesses from the October Nor'Easter. President Clinton issued a major disaster declaration on November 19 at the request of Governor George Pataki, identified as DR-1146 (FEMA, 1996). Public assistance funding was provided for infrastructure repairs, including: damage to roads, bridges and other county and local facilities. Preliminary damage assessments for the two counties totaled

more than $3.5 million. This was the 1st Nor'Easter to strike the region in years, causing widespread flooding and causing the first game of the World Series to be canceled. Governor Pataki announced additional flood aid for this Nor'Easter on May 14, 1997, for SC totaling $285,775.

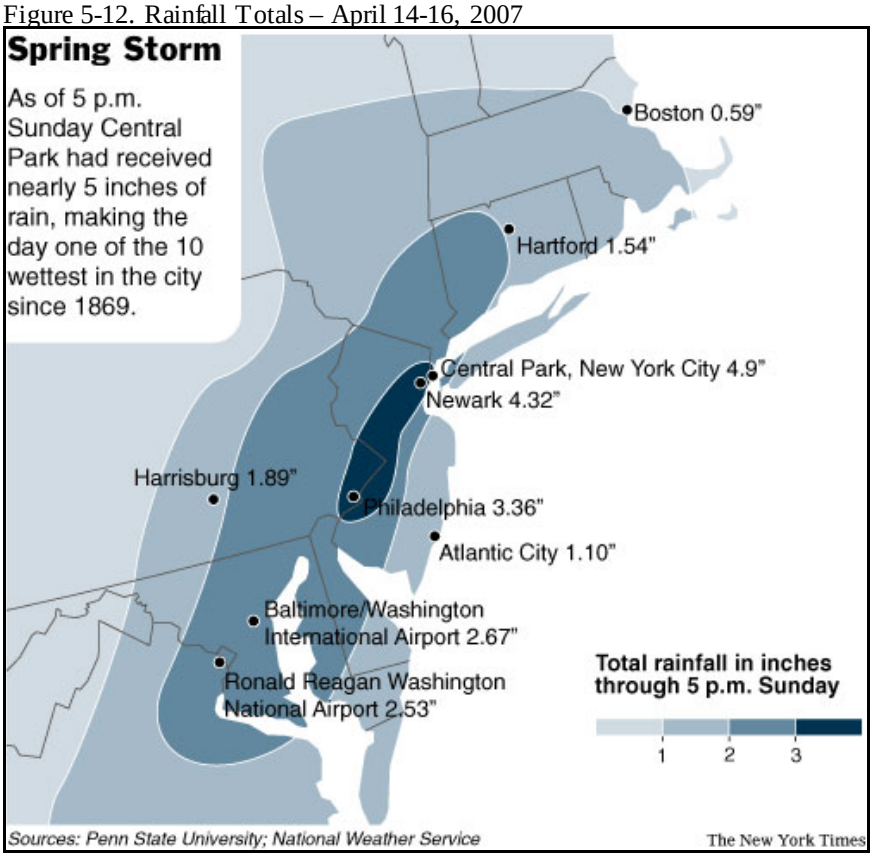
April 14-16, 2007 ("The Beast from the East") (FEMA DR-1692): The Spring Nor'Easter of 2007, affected mainly the northeastern parts of the U.S, from 14 to April 16, 2007 (Figure 5-12). The combined effects of high winds, heavy rainfall, and high tides led to significant coastal erosion, flooding, storm damages, power outages, and evacuations, and disrupted traffic and commerce. The storm caused several fatalities. It hit the NYS area before dawn with pounding wind and rain, causing tides to surge against coastal beaches and riverfront communities, forcing the cancellation of more than 500 flights at the three major airports, closing 20 roads in New Jersey and others in NYS, cutting off power to 18,500 customers in three states, and tearing off a roof at an apartment complex on Long Island. In Patchogue, high winds ripped the roof off a building in the Fairfield Apartments, and eight families were moved to another building in the complex. On Fire Island, where winds up to 50 miles an hour came in from the ocean, more than 1,000 people voluntarily evacuated (McFadden, 2007).

Some of the impacts of this Nor'Easter within Long Island included: flooding in low-lying areas such as Freeport, and along Dune Road in Southampton and Asharoken Avenue in Asharoken. Route 25 in East Marion -- the only road to the Orient Ferry -- was closed and impassible There were reports of fallen trees, downed power lines, flooding, and threats of erosion across the region. For one night, Sunrise Highway in Water Mill was closed both ways because of downed power lines and trees. More than 500 flights were canceled at the region's major airports, though Long Island MacArthur Airport in Islip reported only scattered delays on some flights (Freedman, 2007).

On April 30, 2007, U.S. Senator Charles E. Schumer, SC Executive Steve Levy, and Babylon Town Supervisor Steve Bellone toured storm-hammered areas in Gilgo Beach in the Town of Babylon to assess the damage and discuss the recovery efforts from the destructive April 2007 Nor'Easter. This storm caused over $26 million in damage in SC, including significant erosion, flooding, and damage to homes, businesses, and infrastructure. Cupsogue Beach County Park in Westhampton was hit with over $5 million in damage while millions more in damage affected Smith Point County Park in Shirley. Major erosion and flooding also occurred at places like Captree State Park, Heckscher State Park, Caumsett State Park, Orient Beach, and Montauk Point. The storm led to the partial collapse of a road at Orient Point State Park. According to the Town of Babylon, homes and businesses south of Montauk Highway encountered significant damage. On the East End, towns like Southold heard from homeowners with flooded basements. Long Island was also plagued by flooding, especially in communities like Copiague, Amityville, Lindenhurst, Lake Ronkonkoma, and Babylon. Rain totals ranged from 1.5 inches to close to 4 inches. Across Long Island, almost 18,500 LIPA customers experienced power outages (Schumer, 2007).

As of May 3, 2007, FEMA announced that SC, along with other counties, was declared a disaster area eligible for Public Assistance, identified as DR-1692. Disaster assistance was approved for state and local government and certain non-profit organizations in 12 NYS counties, including SC (Figure 5-15). Disaster aid for SC has not been reported (FEMA, 2007).
Details regarding coastal erosion impacts from this storm are presented later in this section (Section 5.4 - Coastal Erosion).

Figure 5-12. Rainfall Totals – April 14-16, 2007



Source: (McFadden, 2007)

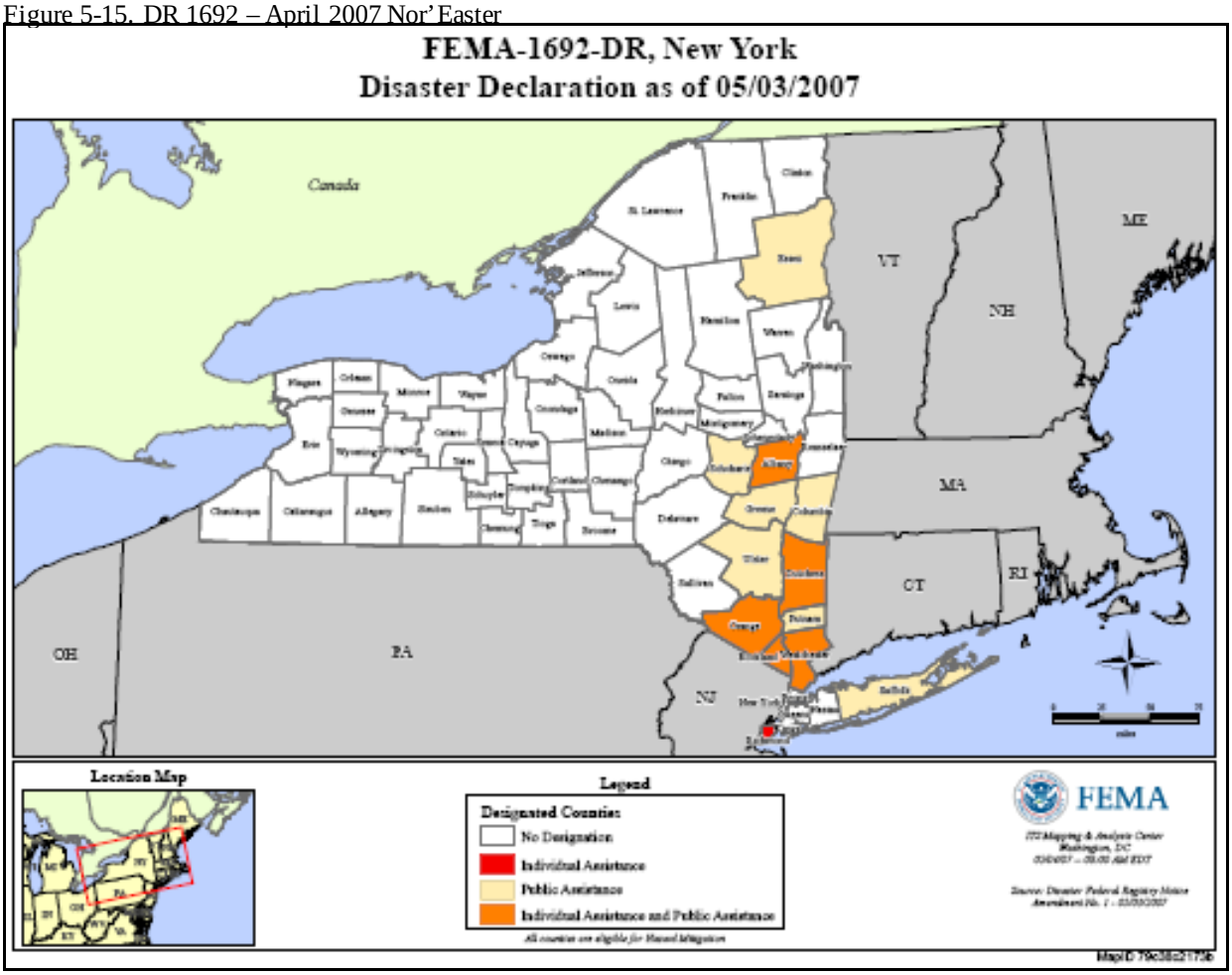
Figure 5-13. Huntington, NY – April 14-16, 2007

Note: A car drives through a flooded street during a spring storm in Huntington, New York, Sunday, April 15, 2007.
Source: (Newsday, 2007)

Figure 5-14. Lindenhurst, NY – April 14-16, 2007

Note: A home on Bayview Avenue in Lindenhurst is surrounded by water. Heavy winds and rain pounded the area, causing ocean water to break over dock.

Figure 5-15. DR 1692 – April 2007 Nor'Easter



Source: (FEMA, 2007)

Probability of Future Events

In Section 5.3, the identified hazards of concern for the SC were ranked. The NYS HMP conducts a similar ranking process for hazards that affect the State. The probability of occurrence, or likelihood of the event, is one parameter used for ranking hazards. Based on historical records and input from the Planning Committee, the probability of occurrence for Nor'Easters in SC is considered frequent [hazard event that occurs more frequently than once in 10 years ($>10^{-1}$/yr), as presented in Table 5-4]. It is estimated that SC and all of its jurisdictions will continue to experience the direct and indirect impacts of Nor'Easters/extratropical storms annually that will induce direct impacts and may induce secondary hazards such as coastal erosion, coastal flooding, utility failure, and transportation accidents.

VULNERABILITY ASSESSMENT

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. For Nor'Easter events, all of SC has been identified as the hazard area. Therefore, all assets in SC (population, structures, critical facilities and lifelines), as described in the County Profile section (Section 4), are vulnerable. The following text evaluates and estimates the potential impact of Nor'Easter events on SC including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact, including: (1) impact on life, safety and health of County residents, (2) general building stock, (3) critical facilities, and (4) economy
- Further data collections that will assist understanding of this hazard over time
- Overall vulnerability conclusion

Overview of Vulnerability

As described earlier, Nor'Easters are one of two types of coastal storms that affect Long Island (the other being a hurricane). These two types of storms can cause a similar level of devastation (Cashin, 1994). The entire inventory of the County is at risk of being damaged or lost due to impacts of Nor'Easters. Certain areas, infrastructure, and types of building are at greater risk than others due to proximity to falling hazards and their type of construction. The specific impacts on population, existing structures, critical facilities and the economy are presented in the hurricane, flooding, coastal erosion and severe winter storm hazard profiles.

Data and Methodology

Nor'Easters can cause heavy snow, rain, gale force winds, and oversized waves (storm surge) that can cause beach erosion, coastal flooding, structural damage, power outages and unsafe human conditions. Step 4 in FEMA's How To 386-2 describes the factors to consider when assessing the vulnerability of buildings in coastal storms; these include: (1) storm surge flooding; (2) erosion or scour; and (3) strong winds. Potential losses associated with high wind events were calculated for SC using HAZUS-MH for two probabilistic wind/hurricane events, the 100-year and 500-year MRP events (see the Hurricane hazard profile). To assess SC's vulnerability to coastal flooding and coastal erosion, potential losses were calculated for SC using HAZUS-MH for 100- and a 500-year MRP flood events and the CEHA data provided by NYSDEC to determine what assets are exposed to coastal erosion (see the Coastal Erosion hazard profile). To estimate losses due to heavy snow, historic data and current modeling tools are not considered adequate to estimate specific losses that are a potential for this hazard. As an alternate approach, this plan considers percentage damages that could result from severe winter storm conditions (see the Severe Winter Storm hazard profile).

Impact on Life, Health and Safety

The entire County is identified as the hazard area vulnerable to Nor'Easters. According to the 2000 U.S. Census, SC had a population of 1,419,369 people. Vulnerable populations, including the elderly and low income populations, are considered most susceptible to the Nor'Easter hazard. Socially vulnerable populations are most susceptible, based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Low

income residents may not have adequate housing able to withstand high winds, rain and snow associated with Nor'Easter events. The 2000 U.S. Census indicates that there are 5,374 mobile homes in SC.

Impact on General Building Stock

The entire general building stock inventory in the County is vulnerable to Nor'Easters. The data in HAZUS-MH estimates that there are 461,871 structures in SC, with a total building replacement value (structure and content) of greater than $210 billion. Approximately 99% of the buildings and 84% of the building stock structural value are associated with residential housing. Because of differences in building construction, residential structures are generally more susceptible to coastal storms than commercial and industrial structures. Please refer to Section 4 (County Profile) which presents building stock statistics by occupancy class for the County.

HAZUS-MH was used to estimate potential losses to structures due to high wind events. Please refer to the Hurricane profile later in this section for a detailed look at potential estimated building values (structure and content) damaged by 100-year and 500-year MRP wind events (hurricane). In addition, a specific area that may be vulnerable to the Nor'Easter hazard is the floodplain, especially low-lying coastal zones. Infrastructure at risk due to coastal flooding is presented in the Flood hazard profile.

There are certain limitations to using HAZUS. This plan utilized HAZUS default data to perform a HAZUS Level 1 analysis. HAZUS is only intended to provide an estimation of building replacement value, using estimates for typical buildings in a given census block. It is only as current and/or accurate as the US Census 2000 data, and it does not reflect specific local building conditions, such as a higher percentage of luxury structures, higher local costs to procure and transport building materials through New York City, and the recent dramatic worldwide increases in the cost of building construction materials and products and/or services dependent upon the price of petroleum. Plan participants have indicated the values presented herein significantly underestimate the actual Replacement Cost Values (RCV) in Suffolk County.

In the past, hundreds of homes have been destroyed and thousands damaged due to the wind, precipitation and/or flooding associated with Nor'Easter events. More specifically, Nor'Easters have also caused roofs to collapse due to the weight of heavy snow. Coastal communities are particularly vulnerable, especially structures on the protective barrier beaches.

Impact on Critical Facilities

All critical facilities are considered vulnerable to the Nor'Easter hazard. Section 4 of this Plan (County Profile) discusses the critical facilities in SC and the estimated replacement value for critical facilities and infrastructure. Estimated potential impact on these facilities is outlined in the hurricane, flood and severe winter storm hazard profiles. Because power interruption can occur, backup power is recommended for all critical facilities.

Impact on Economy

The high winds and heavy precipitation associated with Nor'Easter events often cause power outages, disruptions to transportation corridors and equipment, and loss of workplace access, all of which impact the local economy. Additionally, damage can also be inflicted by trees, branches, and other objects that fall onto power lines, buildings, roads, and vehicles. Sufficient information was not available to perform a detailed assessment of estimated losses to the economy. It is estimated that the impact to the economy, as a result of a Nor'Easter event, would be considered "high" in accordance with the risk ranking shown in Table 5-5.

Additional Data and Next Steps

In summary, Nor'Easters can cause heavy precipitation, gale-force winds, and oversized waves (storm surge) that can cause beach erosion, coastal flooding, structural damage, power outages and unsafe human conditions. This level of devastation is similar to that of a hurricane. Over time, the County will obtain additional data to support the analysis of this hazard. The County will continue to work together with local, state, and federal entities to learn more about the hazards associated with a Nor'Easter, and support further mitigation efforts as discussed in Section 6 to reduce the losses when future Nor'Easter events occur. Data that will support future analysis would include additional detail on past hazard events and impacts, specific building information such as first floor elevation, type of construction, foundation type and details on protective features (e.g., hurricane straps). In addition, information on particular buildings or infrastructure age or year built would be helpful in future analysis of this hazard.

As will be described later in the hurricane hazard profile, HAZUS-MH was customized to analyze the combined wind and flood hazards for SC. In time, HAZUS-MH will be released with modules that address wind and flooding as one model. As this version of HAZUS-MH is released, SC can run analyses for an overall picture of the associated wind and flood damages caused by hurricanes and use these results to also estimate damages caused by Nor'Easters. Additionally, refinement of floodplain maps and improvement of local inventory data will support refined analyses using HAZUS-MH over time.

Overall Vulnerability Assessment

Historically, Nor'Easters have devastated the study area, causing impacts and losses to the County's structures, facilities, utilities, and population. Existing and future mitigation efforts should continue to be developed and employed that will enable the study area to be prepared for these events when they occur. The overall hazard ranking determined by the Planning Committee for this hazard is high (see Tables 5-6 and 5-7).